Measuring Earths Magnetic Field

using a

Helmholtz Tangent Galvanometer

Items Required:

- Helmholtz Coil. Make one here: http://tinyurl.com/pes6tzp
- Benchtop Power Supply
- Connecting Wires
- Field Compass
- Multimeter (Amps Setting)


GW INSTEK GPD-4303S
DC Power Supply
CH4 CH2 CH1 CH3
V
A
MEMORY
RECALL / SAVE
1
2
3
4
LOCK
UNLOCK
CH1/3
CH2/4
BEEP
PARA /INDEP
SER /INDEP
OUTPUT
VOLTAGE
Push
FINE
CURRENT
Push
COARSE/FINE
FINE
Long Push
POWER
0 – 5V , 1A
C.V
C.C.
CH4
0 – 30V , 3A
SLAVE
C.V
C.C. PAR
CH2
GND
0 – 30V , 3A
MASTER
C.V
C.C.
CH1
0 – 5V , 3A
5 – 10V , 1A
C.V.
C.C
CH3
SERIES OUTPUT
COM
PARA OUTPUT
FLUKE 289
TRUE RMS MULTIMETER
HOLD
MIN MAX
RANGE

If you don’t have a benchtop PSU,

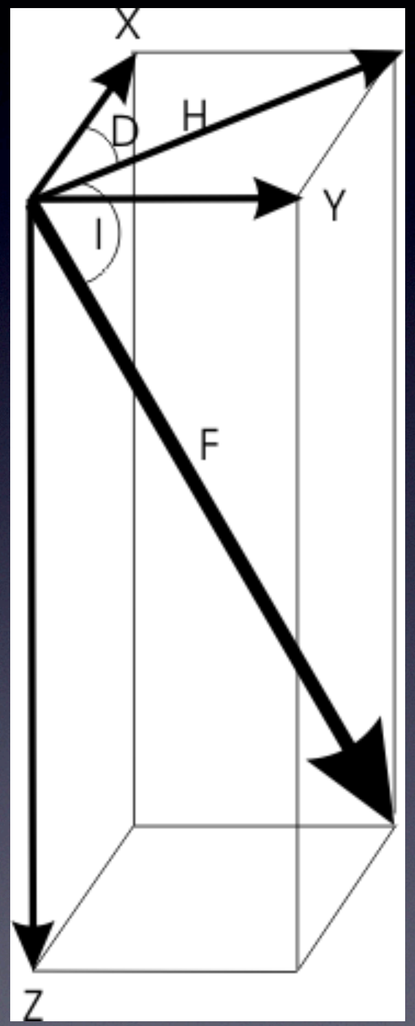
you can substitute with a DC PSU

and Rheostat.

IMPORTANT:

Do not exceed the current rating of your Helmholtz coil and power supply

Magnetic Components



- There are a number of metrics for the Earths Magnetic Field. We're interested in the Horizontal Magnetic Component, also known as "H" and is where a compass points when held on a level plane.
- More information on the various components: http://www.geomag.nrcan.gc.ca/mag_fld/comp-en.php

Find A Magnetically Clean Location

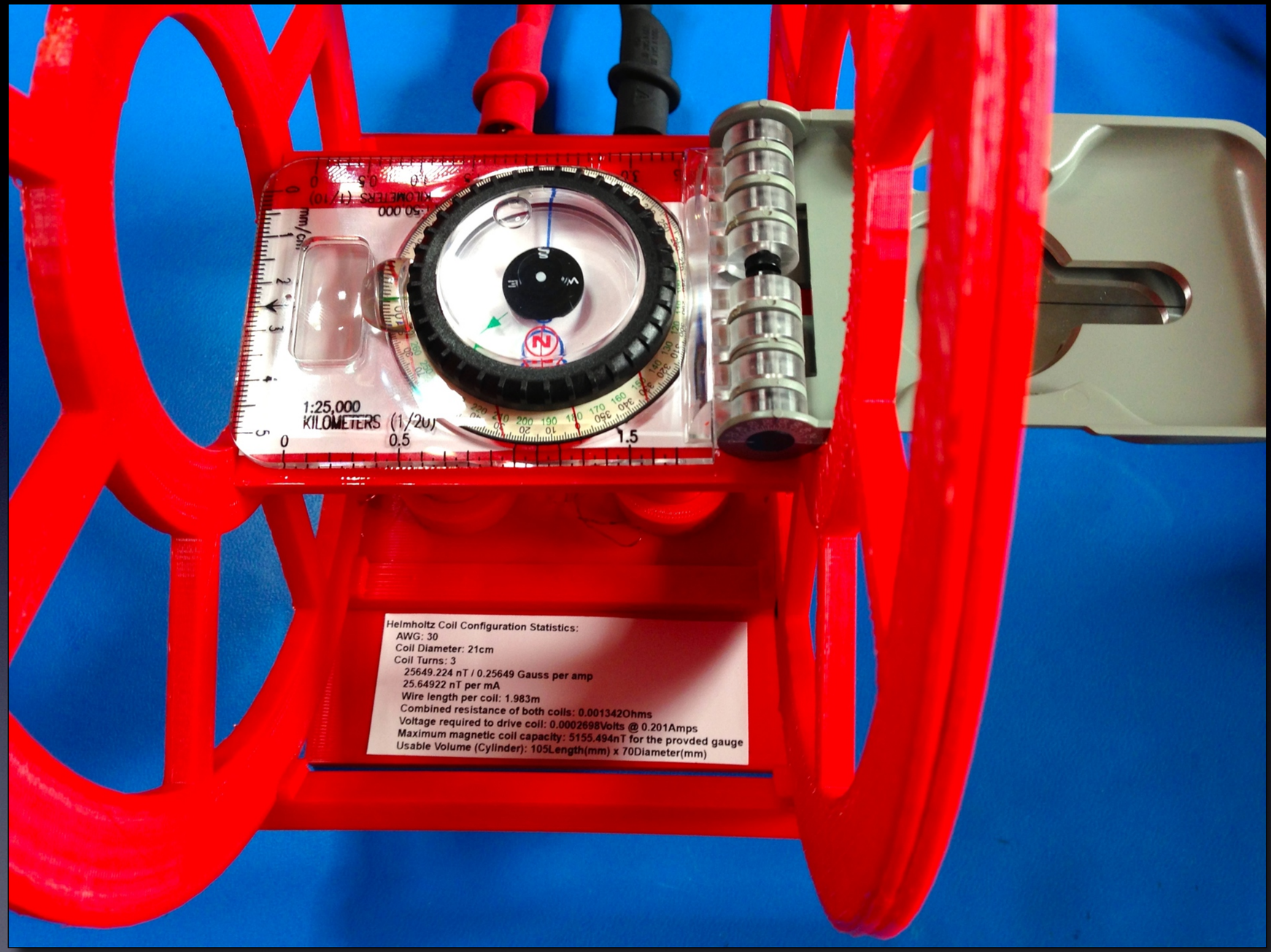
- Use the compass to find a good location
- Move the compass around the location to detect sources of magnetism (ferrous metal objects, magnets, electronics etc.) and avoid them
- Find somewhere the compass points to Magnetic North for a few feet in all directions

Connect Coil

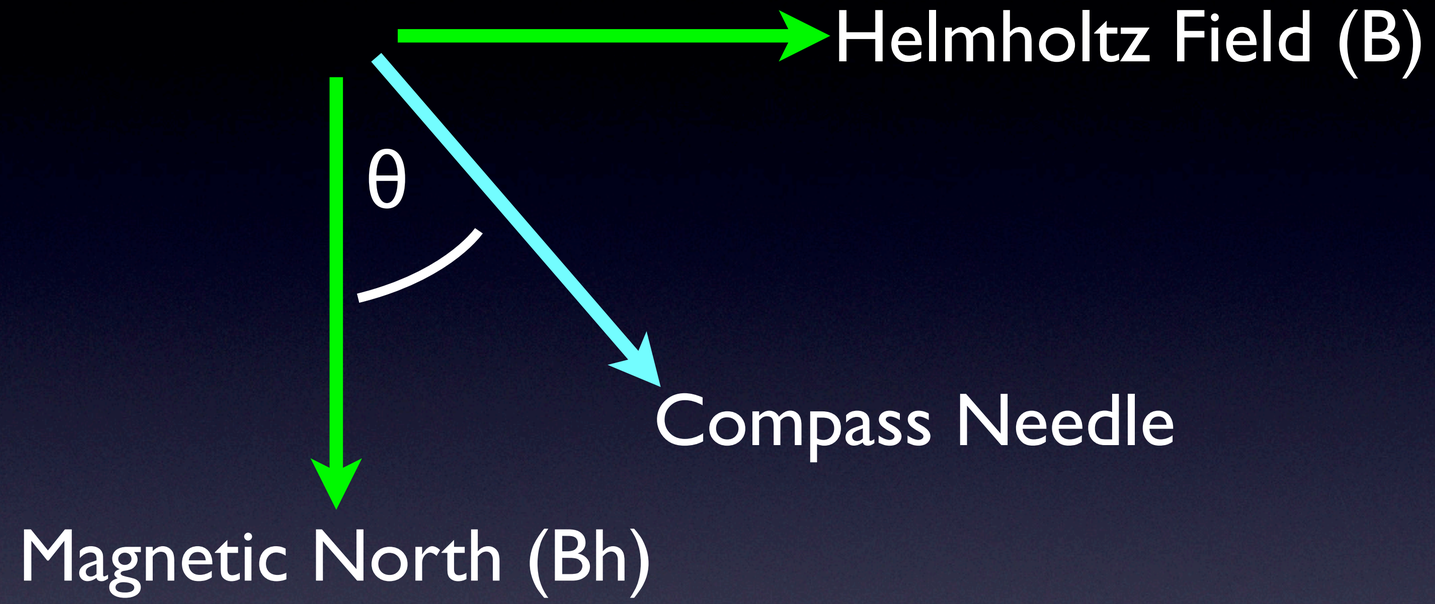
- Connect the benchtop power supply via an Ammeter to the coil
- If using a regular power supply, connect via an Ammeter and a Rheostat, make sure that the Rheostat is set for minimum current

Place Compass In Coils and Orientate North

- Ensure PSU is off
- Place the compass in the magnetically uniform cylinder inside the coil
- Orientate the coil so that Magnetic North is parallel with the plane of the wire in the coils
- This will mean that the cylinder through the coils will be lying East/ West


1:25,000
KILOMETERS (1/20)
0
0.5
1.5
Helmholtz Coil Configuration Statistics:
AWG: 30
Coil Diameter: 21cm
Coil Turns: 3
25649.224 nT / 0.25649 Gauss per amp
25.64922 nT per mA
Wire length per coil: 1.983m
Combined resistance of both coils: 0.001342Ohms
Voltage required to drive coil: 0.0002698Volts @ 0.201Amps
Maximum magnetic coil capacity: 5155.494nT for the provded gauge
Usable Volume (Cylinder): 105Length(mm) x 70Diameter(mm)

Some Theory - Tangent Law



The Tangent Law Of Magnetism states, when you have a magnet in one direction and you apply a magnet at 90 deg, the resulting field is related by the tangent:

$$B = Bh \times \tan(\theta)$$

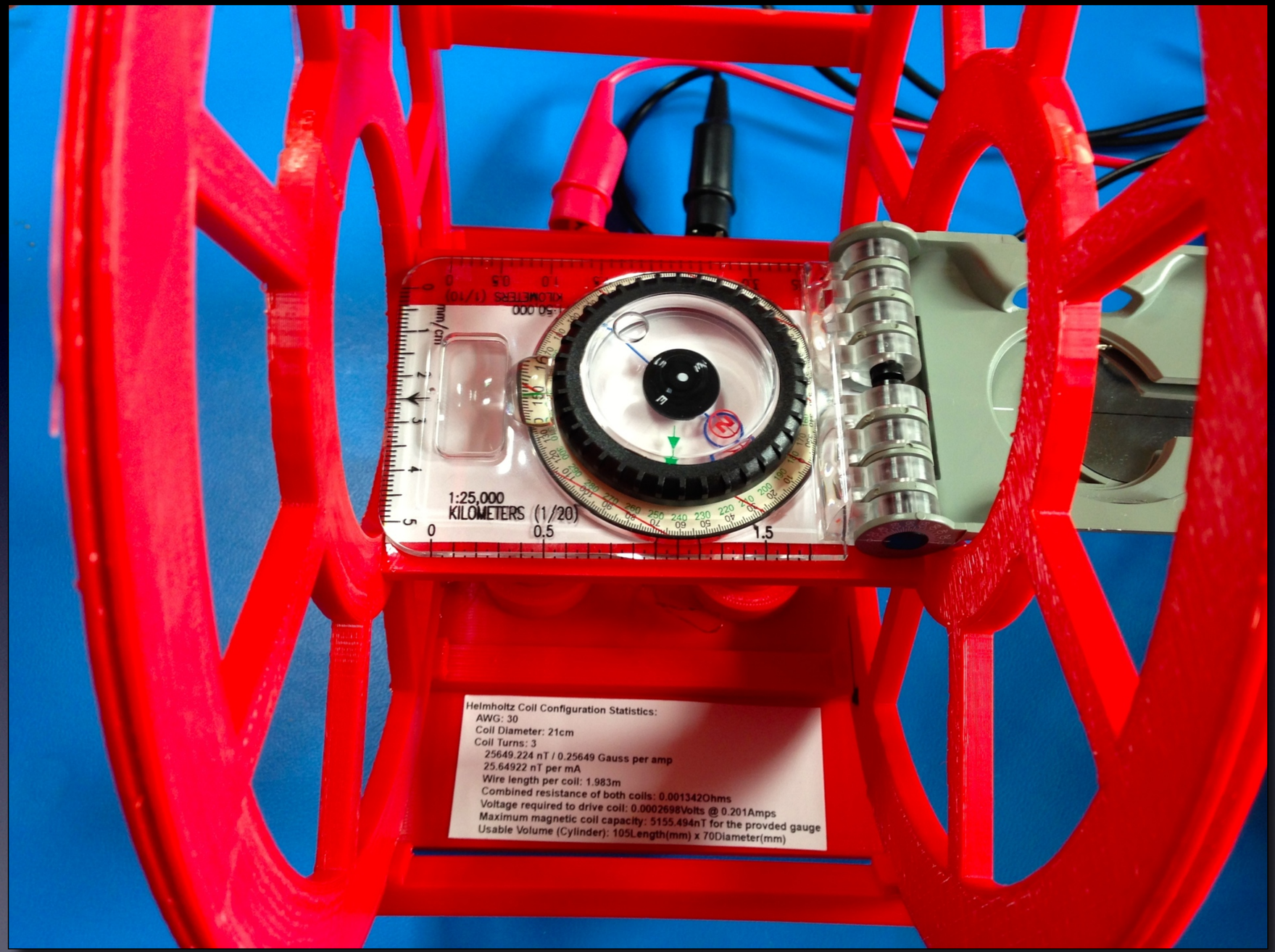
Some Theory - Tangent Law

Because Tan(45) = 1.0, if current is applied to the Helmholtz coil until the compass needle deflects from Magnetic North by 45 degrees, then B=Bh.

At this point the magnitude of the field in the Helmholtz coil is equal to the field of Magnetic North.

Deflect Needle To 45 Degrees

- Increase current in the Helmholtz Coil until the needle deflects 45 degrees
- Note the current (Current 1)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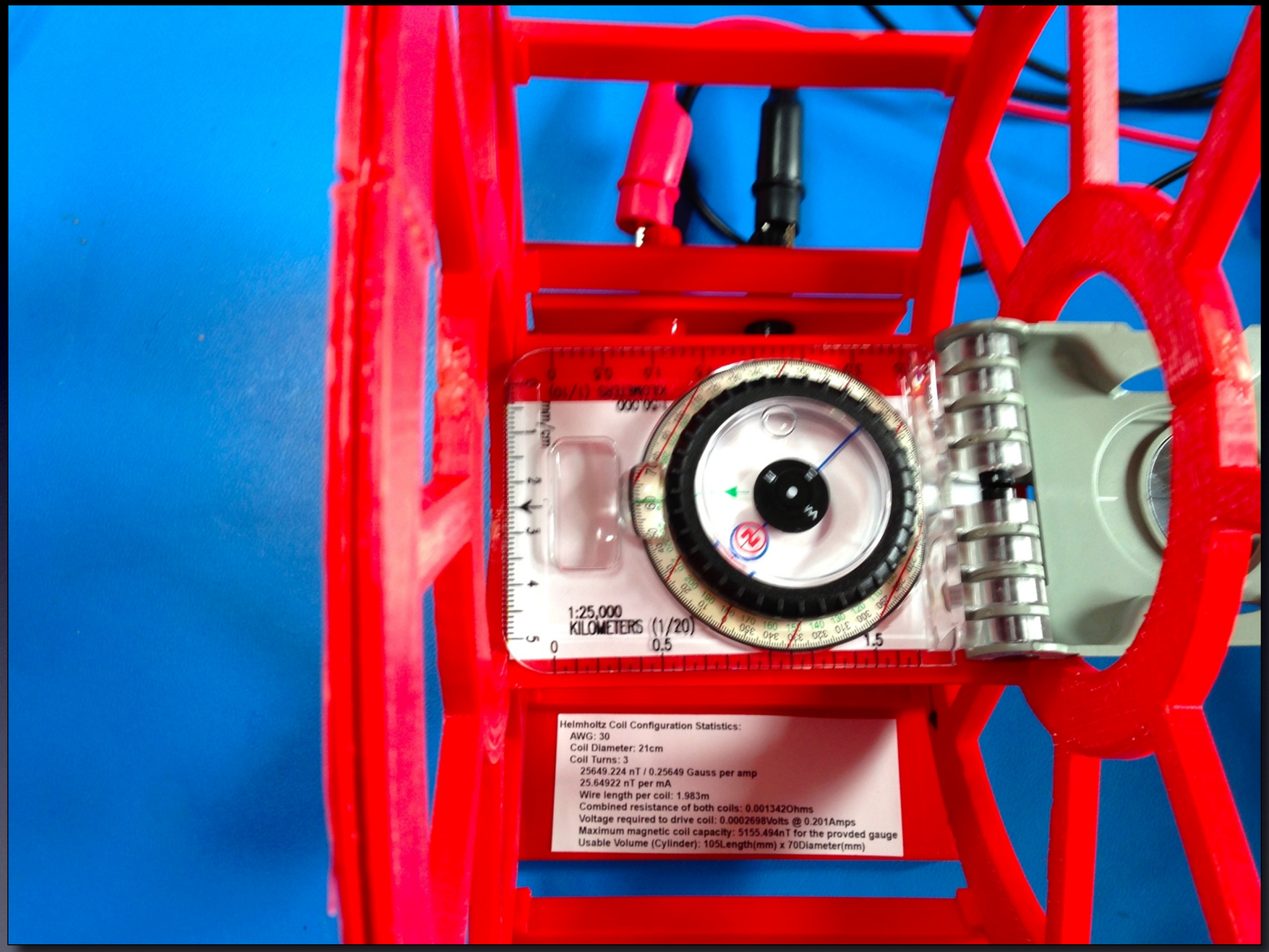
Deflect Needle To -45 Degrees

- Reverse the current in the coil so that the needle deflects in the opposite direction
- Increase current in the Helmholtz Coil until the needle deflects -45 degrees
- Note the current (Current 2)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Average Current Readings

- We take 2 current measurements in the previous steps to reduce inaccuracy in our alignment
- Average the 2 current measurement, let's call this I (current mA)

Determine Coil Strength

- Figure out the nanoTeslas (nT) per mA for your coil. If you're using my coil designer, then OpenScad provided that figure for you, otherwise:

- nT Per mA (S) = (899.17629 * N) / R where:
  - N = Number of turns on one coil
  - R = Radius in millimeters

Calculate Magnetic Earth Strength

- Using “S” (nT per mA) and “I” (average current of the Helmholtz Coil in mA), we have:

- Horizontal Magnetic Component in nT (Bh) = S * I

Comparing Bh To Your Location

- Option 1: http://www.ngdc.noaa.gov/geomag-web/#igrfwmm
  Enter Latitude/Longitude and elevation. "Horizontal Intensity" is the Bh

- Option 2: http://geomag.nrcan.gc.ca/calc/mfcal-en.php
  Enter Latitude/Longitude. "H(nT)" is the Bh

Music

Demain je change de vie - INSTRUMENTAL VERSION

Lohstana David

Jamendo

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